What is a logical argument?

Developing Academic Writing

Logical relations

- Deductive logic
  - Claims to provide conclusive support for the truth of a conclusion
  - Valid argument, true premises yield true conclusion
- Inductive logic
  - Arguments support a conclusion, but do not claim to show that it is necessarily true.
  - Strong arguments suggest likely conclusions.

Deductive logic

- Categorical propositions
  - Deductive arguments are either valid or invalid.
  - Premises are either true or not true.

  - If the argument is valid and the premises are true, then the conclusion is true.

Deductive logic

- Categorical propositions have a truth value.
  - All dogs are mammals. (All *S* is *P*)
  - No dogs are fish. (No *S* is *P*)
  - Some mammals are carnivores. (Some *S* is *P*)
  - Some mammals are not carnivores. (Some *S* is *not-P*)

The truth of a proposition is determined by its "fit" with the world.

  - "Some mammals are carnivores" is true if and only if there are some mammals that eat meat.

Implication

- A set of two facts (propositions)
- The first implies the second.
  - If the first is true, then the second must be true.
  - If the second is NOT true, then the first must not be true.

Implication: Example

Premise 1: If a river is narrow, it is easy to cross.

Premise 2: Yada River is narrow.

Conclusion: Yada River is easy to cross.

Implication: Example

Premise 1: If a river is narrow, it is easy to cross.

Premise 2: Kiso River *is not* easy to cross.

Conclusion: Kiso River is not narrow.

Syllogisms

- Syllogism: A conclusion inferred from two premises

  P1. All dogs are mammals.

  P2. Katie is a dog.

  C. Therefore, Katie is a mammal.

Quiz

- **Which premise provides the best support for the conclusion, “Peter is in Japan”?**
  1. **Peter always watches the Sumo Kyushu Basho.**
  2. **Peter is in Sapporo.**
  3. **Peter works for Mitsubishi.**

Quiz

- **Peter is in Sapporo.**
- **Sapporo is in Japan.**
- **Therefore, Peter is in Japan.**

Deductive logic

- If the argument is valid and the premises are true, then the conclusion is true.
  - Valid: The argument (relation of the premises) *necessarily entails* the conclusion.
  - True: The premises accurately reflect the world.
- Deductive logic is used to prove that the conclusion must be true (if the premises are true).

Inductive logic

- Does not seek to prove the conclusion
- Offers *support* for a *probable* conclusion
  - Statistical likelihood
  - Generalization
  - New data can strengthen (or weaken)

Inductive logic

- “A great many arguments are not designed to demonstrate the truth of their conclusions [but] to establish them as probable.”
  - Irving Copi, *Introduction to Logic*

Statistical syllogism

- Statistical syllogism
  - Like a syllogism, conclusion is inferred from two premises.
  - Unlike (deductive) syllogism, the premises are not categorical.

  - X portion of S is Q.
  - J is S.
  - Therefore, J has X likelihood of being Q.

Statistical syllogism

- X portion of S is Q.
- J is S.
- Therefore, J has X likelihood of being Q.

- Most children who survive until their fifth birthday live to be over 70 years old.
- Kobayashi is over five years old.
- Therefore, Kobayashi will most likely live to be over 70 years old.

Statistical syllogism

- Ninety-two percent of Nagoya University students are from Japan.
- Suzuki is a Nagoya University student.
- Therefore, Suzuki is likely (92%) to be from Japan.

Be careful!

- An individual may be a member of many classes.
- Arguing from an inappropriate class may yield a conclusion that appears strong, but is misleading or false.

Be careful!

- Ninety-two percent of Nagoya University students are from Japan.
- Chen is a Nagoya University student.
- Therefore, Chen is likely (18% , to be from Japan.
- But Chen is a graduate student, and only 78% of Mei-Dai graduate students are from Japan.

Be careful!

- Don't confuse particular (*some, most, 92%*) for categorical (*all, none*) statemer

Most birds can fly.
This penguin is a bird.
Therefore, this penguin most likely can fly.

Logic looks OK, but conclusion is false.

- Particular cases may not follow general rule.
- Be careful to account for possible exceptions.

Don't ignore counter-evidence.

Analogy

- Argument from analogy

  P is similar to *Q* regarding property *a, b, c*

  P has property *d*

  Q probably has property *d*

Analogy

- Apples are deciduous trees. Pears are deciduous trees.
- Apples set fruit in fall. Pears set fruit in fall.
- Apples are cold-hardy. Pears are cold-hardy.
- Apples can grow at high altitude.

- Therefore, it is likely that pears can grow at high altitude.

Generalization

- Inductive generalization

  S_1 is P.

  S_2 is P.

  Therefore, it is likely that S_3 is P.

(OR) Therefore, it is likely that all S are P.

  - Resembles analogy
  - Strengthened by repeated measures

Generalization

Twenty-seven patients came to the hospital with yellow fever. Each of the 27 patients was bitten by mosquitoes. Therefore, it is likely that everyone with yellow fever was bitten by mosquitoes.

Generalization

- Statistical generalization

  X % of S observed are P.

  Therefore, X % of all S are probably P.

Generalization

A sample of 1,054 voters were asked whether they approve of the government. Fifty-eight percent of people surveyed say they approve of the government; 34% say they disapprove.

Therefore, it is likely that more than half of all voters approve of the government.

Generalization

- Beware of hasty generalization: big conclusion based on a small sample.

Since entering this town, I have seen three people. All three were children. Therefore, the people in this town are probably all children.

Logic in reading

- When you read, ask yourself:
  - What is the conclusion?
  - What is the argument? (In other words, what premises lead to the conclusion?)
  - Is the argument valid?
  - Are the premises true?

Logic in reading

"To those who scare peace-loving people with phantoms of lost liberty, my message is this: Your tactics only aid terrorists, for they erode our national unity."

– John Ashcroft (US politician)

Logic in reading

"To those who scare peace-loving people with phantoms of lost liberty, my message is this: Your tactics only aid terrorists, for they erode our national unity."

– John Ashcroft (US politician)

- What is the conclusion?
  - People who 'scare with phantoms of lost liberty' aid terrorists.
    (People who argue for liberty aid terrorists.)

Logic in reading

"To those who scare peace-loving people with phantoms of lost liberty, my message is this: Your tactics only aid terrorists, for they erode our national unity."

– John Ashcroft (US politician)

- What are the premises?
  - People who argue for liberty 'erode our national unity' (disagree with the US government).
  - Terrorists disagree with the US government.

Logic in reading

- Is the argument valid?
  - People who argue for liberty disagree with the US government.
  - Terrorists disagree with the US government.
  - Therefore, people who argue for liberty aid terrorists.

All P is M.
Q is M.
∴ All P is Q.

Logic in reading

- Is the argument valid?
  - All rabbits run fast.
  - Homare Sawa runs fast.
  - Therefore, Homare Sawa is a rabbit.

✕ Not valid

All P is M.
Q is M.
∴ All P is Q.